B.Sc. (Honours) in Geology
Under the Framework of Honours School System
2019-20
PREAMBLE

The Centre of Advanced Study in Geology was established in the Panjab University in 1958. The Centre was soon recognized for its contribution by the University Grant Commission (UGC), which raised its status to that of the Centre of Advanced Study (CAS) in Palaeontology and Himalayan Geology in the year 1963. The Centre has continued to get funding under SAP-CAS programme of the UGC. The Centre has also received funding from the Department of Science and Technology, Government of India under COSSIST (1984-1989) and FIST (2002-2007) for improving the infrastructure in research and teaching.

Now the Centre has been renewed as Centre of Advanced Study under Special Assistance Programme of the UGC for a period of 5 years (1-4-2012 to 31-3-2017) in Phase-VII with the financial assistance of Rs. 148 Lacs in the following thrust areas: Palaeontology - Stratigraphy; Petrology; Hydrogeology & Environmental Geology.

The centre has received national and international honours and distinctions for seminal scientific contributions. The centre is endowed with well-equipped student-faculty interfaced laboratories, such as Scanning Electron Microscopy, Optical Microscopy, Sample Preparation Laboratory, and comfortable academic working environs. Besides, an internationally famous museum, a pride of the centre, is the mainstay for school children and lay public, where all and sundry are served hands-on activity for observing and understanding various aspects of earth sciences.

The Centre strives to maintain high standards of teaching by making its students not only aware of various geological problems, but also to study Geology as a quantitative science. The core subjects are taught at undergraduate levels, while interdisciplinary and modern courses are covered in the postgraduate level. The curriculum pertaining to B.Sc. (Honours) (3 Year course & 6 Semesters) in the subject of Geology under Honours School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment.
# COURSE STRUCTURE

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<td>Fossils &amp; their Applications</td>
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<td>DSE4</td>
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<td>Fuel Geology</td>
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C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective

*: GE subjects are to be selected by the students from the pool of GE Subjects offered by various Departments of the University.
*GENERIC ELECTIVE SUBJECTS (Offered by Geology Department) for students of other departments

1. GEO-C-GE1B: Essentials of Geology
2. GEO-C-GE2B: Minerals and Rocks
3. GEO-C-GE3B: Structural Geology
4. GEO-C-GE4B: Fossils & their Applications

SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)

1. GEO-SEC1: Field Geology 1 – Basic Field Training
2. GEO-SEC2a: Field Geology 2 – Geological Mapping
3. GEO-SEC2b: Field Geology 3 – Himalayan Geology Field
4. GEO-SEC2c: Field Geology 4 – Stratigraphy and Paleontology Related Field
5. GEO-SEC2d: Field Geology 5 – Precambrian Geology Field

DISCIPLINE SPECIFIC ELECTIVE

1. GEO-DSE1: Geophysics
2. GEO-DSE2: Earth’s Climate and Environment
3. GEO-DSE3: Evolution of Life Through Time
4. GEO-DSE4: Fuel Geology

*Courses under these will be offered only if a minimum of 10 students opt for the same

Pattern of End-Semester question paper

The theory question paper for the end-semester examination will have nine questions, with 20 marks reserved for first question, which is compulsory. Further, the latter would comprise of 10 short answer questions, without any choice, covering the whole syllabus. The remaining 4 questions carrying 15 marks each, are to be attempted from the 4 Units. Each unit would comprise of two questions.

Pattern of Mid-Term question paper

The question paper for the mid-term examination will have two questions, each being comprised of four parts with equal marks. Five parts have to be attempted, selecting at least two parts from each question.
B.Sc. (Hons.) Course in Geology

I Year

Semester I and II
B.Sc. (Hons.) Geology

Outlines of Tests, Syllabi and Courses of Reading for B.Sc. (Honours: under the Framework of Honours School System) I Year in Geology (Choice Based Credit System) Examinations 2019-20, 2020-21 and 2021-22

I Semester Examination

<table>
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<tr>
<th>Paper</th>
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<th>Credit</th>
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Total Credits & Marks 12 300

Paper I: EARTH SYSTEM SCIENCE - (Course No. GEO-C1)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objective: This basic fundamental course aims to understand various conceptual aspects of Earth’s evolution and its constitution. It is also aimed to study a brief account of plate tectonic processes, about hydrosphere and atmosphere and also to understand fundamentals of stratigraphy including the geological time scale.

UNIT 1: Earth as a Planet (15 hrs)


UNIT 2: Plate Tectonics (15 hrs)

UNIT 3: Hydrosphere and Atmosphere (15 hrs)


UNIT 4: Understanding the Past from Stratigraphic Records (15 hrs)


SUGGESTED READING


Paper II: MINERAL SCIENCE - (Course No. GEO-C2)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objective: This course aims to understand the basic concepts of crystals and crystal systems, and the characteristics and properties of various crystal systems. This course also introduces the general physical and optical characteristics of minerals with an aim to carry out a detailed study of physical & optical properties and chemical compositions of some important rock-forming silicate minerals and some non-silicates.
UNIT 1: Crystallography (15 hrs)

Elementary ideas about crystal morphology: Forms and morphology of crystals; Open and closed forms, Zone and Zone axes, Like and unlike faces, Interfacial angle and its measurements; Law of constancy of interfacial angle; Crystal parameters and indices: Weiss and Miller’s systems of notation; Law of rational indices.

Study of Elements of crystal symmetry and aspects of crystal structures. Classification of crystals into six systems and principles of classification into 32 classes. Study of holohedral class of cubic, tetragonal, orthorhombic, monoclinic, triclinic and hexagonal crystal systems, and hemihedral classes of cubic and hexagonal crystal systems.

UNIT 2: Physical and Optical Characters of Minerals (15 hrs)

Minerals-definition and classification, physical characters of minerals: habit, colour, streak, cleavage, fracture, lustre, hardness and specific gravity; Nature of light and principles of optical mineralogy: polarized light and crossed polarized light; reflection, critical angle, total reflection, refraction and Snell’s law; optical properties of minerals: isotropic and anisotropic minerals, refractive index, relief, colour, pleochroism, birefringence and retardation, interference colours, extinction and its measurement.

UNIT 3: Rock Forming Mineral Groups/Minerals-I (15 hrs)


UNIT 4: Rock Forming Mineral Groups/Minerals-II (15 hrs)

Physical and chemical composition of following common rock-forming minerals/groups of minerals: Sorosilicates – epidote group; Cyclosilicates – beryl, tourmaline and cordierite; Inosilicates – pyroxene group and amphibole group; Phyllosilicates– mica group, talc, serpentine and chlorite; apatite, calcite, barite, fluorite and corundum. Optical Identification of common rock-forming minerals: Sorosilicates, Cyclosilicates, Inosilicates and Phyllosilicates.

SUGGESTED READING

**B.Sc. (Hons.) Geology**

**Practical I: EARTH SYSTEM SCIENCE - (Course No. GEO-C1P)**

*Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]*

**Total Lectures: 60**

**Credits: 2**

1. Study of topographic sheets: features and scales.
2. Physiographic description of an area.
3. Study of major geomorphic features.
4. Distribution of lithostratigraphic units.
5. Major oceanic currents of the world.

**Practical II: MINERAL SCIENCE - (Course No. GEO-C2P)**

*Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]*

**Total Lectures: 60**

**Credits: 2**

1. Clinographic projections and study of element of symmetry of the following crystal modals: Cube, Octahedron, Rhombdodecahedron; Tetrahexahedron, Trisoctahedron and Trapezohedron; Zircon, Barite, Gypsum, Hornblende, Beryl, Calcite, Pyritohedron and Tetrahedron.

2. Study of physical properties of mineral group/minerals in hand specimen: Feldspar group, feldspathoid group and silica group. olivine group, garnet group, aluminium silicate group, titanite, staurolite, beryl and tourmaline; pyroxene group and amphibole group; mica group, talc, serpentine and chlorite; apatite, calcite, barite, fluorite and corundum.

3. Study of some key silicate minerals under optical microscope and their characteristic properties.

**II Semester Examination**

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**Practical: Core Course**

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<td>II</td>
<td>GEO-C4P</td>
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</table>

**Total Credits & Marks**

| Total Credits & Marks |  | 12 | 300 |

9
Objective: The aim of this course is to provide elementary idea about concepts of geochemistry, beginning with basic concepts of chemistry, geochemical classification of elements, rules of substitution and types of various elements. An overview of the structure of Earth and use of isotopes in geochronology is also provided. The course also aims to provide basics of aqueous geochemistry and solid earth.

UNIT 1: Concepts of Geochemistry (15 hrs)

Matter and its nature, elements and the periodic table of elements: periods and groups, atomic number, atomic mass and isotopes, ions, molecules and chemical bonding; states of matter, thermal energy and temperature, heat and heat transfer; Geochemical classification of elements; Goldschmidt’s rules of substitution and their modification; Types of elements: transition elements, large-ion lithophile elements, high-field strength elements, incompatible and compatible elements, mobile and immobile elements.

UNIT 2: Layered Structure of Earth and Geochemistry (15 hrs)

Differentiation of the earth, Composition of different layers of Earth; the nuclides and physics of the nucleus; radioactivity: radioactive decay; the law of radioactive decay; Concept of radiogenic isotopes in geochronology and isotopic tracers; Decay schemes of Rb-Sr method, Sm-Nd method, U-Th-Pb method.

UNIT 3: Element Transport (15 hrs)


UNIT 4: Geochemistry of Solid Earth (15 hrs)

Cosmic elemental abundances; Composition of the bulk silicate Earth: major and minor elements in the crust. Analytical methods and results, sources of error, precision and accuracy. The solid Earth – geochemical variability of magma and its products: composition of magma, volatiles in magma, variation diagrams: bivariate and triangular plots; Rare earth elements (REE) diagrams; Spider diagrams. Meteorites.

SUGGESTED READING

UNIT 1: Structure and Topography (15 hrs)

Effects of topography on structural features; Topographic and structural maps; Important representative factors of the map; Concept of dip and strike; Stratum contour, clinometer compass and Brunton compass, bearing and back bearing. Stereographic projection and its use in structural geology. Thickness and width of outcrops, outlier, inlier. Unconformities: significance, onlap, offlap, types and recognition of unconformities.

UNIT 2: Stress and Strain in Rocks; Foliation and Lineation (15 hrs)

Concept of rock deformation: stress and strain in rocks, strain ellipses of different types and their geological significance. Factors controlling behaviour of rocks; Methods of determination of top and bottom of beds.

Description (definition and types) and origin of foliation: axial plane cleavage and its significance; its relationship with bedding. Description (definition and types) and origin of lineation and relationship with the major structures.

UNIT 3: Folds (15 hrs)

Fold morphology; Geometric and genetic classification of folds; Introduction to mechanics of folding: buckling, bending, flexural slip and flow folding. Causes of folding.

UNIT 4: Joints and Faults (15 hrs)

Joints: general characteristics, joint sets, joint system, major joints and their relation with other structure; use of Rose diagram and stereographic projection; joint intensity.


SUGGESTED READING

Practical I: ELEMENT OF GEOCHEMISTRY - (Course No. GEO-C3P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60  
Credits: 2

1. Types of geochemical data analysis and interpretation of common geochemical plots.
2. Geochemical variation diagrams, rare earth elements (REE) and spider diagrams and their interpretations.

Practical II: STRUCTURAL GEOLOGY - (Course No. GEO-C4P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60  
Credits: 2

1. Basic idea of topographic contours; Topographic sheets of various scales.
2. Introduction to geological maps: Lithological and Structural maps.
3. Structural contouring and 3-point problems of dip and strike.
4. Drawing profile sections and interpretation of geological maps of different complexities. Completion of outcrops.
5. Exercises of stereographic and orthographic projections of mesoscopic structural data (planer, linear, folded, etc.).
Outlines of Tests, Syllabi and Courses of Reading for B.Sc. (Honours: under the Framework of Honours School System) I Year (Generic Elective) in Geology (Choice Based Credit System) Examinations 2019-20, 2020-21 and 2021-22

I Semester Examination

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Total Credits & Marks: 6

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Paper I: ESSENTIALS OF GEOLOGY - (Course No. GEO-C-GE1B)

Total Lectures: 60

Objective: *The aim of this course is to introduce the subject of geology along with its various branches and also to provide an introduction to some basic concepts in geology, such as about age of Earth, internal structure of Earth and various internal and external processes, which modify the landscapes and relief of the earth.*

UNIT 1: Introduction to Earth and Planetary Sciences (15 hrs)


UNIT 2: Internal Structure and Rock-Air-Water Interactions (15 hrs)


UNIT 3: Earth History (15 hrs)

UNIT 4: Evolution of Earth’s Landscape and Origins (15 hrs)


SUGGESTED READING


Practical I: ESSENTIALS OF GEOLOGY - (Course No. GEO-C-GE1BP)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

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Total Credits & Marks 6 150
Objective: This course introduces the general physical characteristics of minerals with an aim to carry out a detailed study of physical properties and chemical compositions of some important rock-forming silicate minerals and some non-silicates. The course also introduces the fundamentals of petrology in order to have broad idea of forms, textures and classification of igneous, metamorphic and sedimentary rocks.

UNIT 1: Physical Characters of Minerals (15 hrs)


UNIT 2: Rock Forming Mineral Groups/Minerals-I (15 hrs)

Physical properties, chemical composition, occurrence and uses of following minerals/groups of minerals: Nesosilicates – titanite, staurolite and chloritoid. Sorosilicates – epidote; Cyclosilicates – beryl, tourmaline and cordierite; Inosilicates – pyroxene group and amphibole group; Phyllosilicates – mica group, talc, serpentine and chlorite; apatite, calcite, barite, fluorite and corundum.

UNIT 3: Introduction to Igneous Petrology (15 hrs)

Introduction to petrology. Igneous petrology: introduction to magma; igneous environments; forms and structures of extrusive and intrusive igneous rocks; igneous textures; classification (mineralogical including IUGS and chemical) and nomenclature of igneous rocks; and petrography of common igneous rocks.

UNIT 4: Introduction to Sedimentary & Metamorphic Petrology (15 hrs)

Sedimentary petrology: formation of sediments; types and formation of sedimentary rocks (siliciclastic, biochemical, organic and chemical); sedimentary structures; and diagenesis. Metamorphic petrology: definition of metamorphism; limits and types of metamorphism: metamorphic agents; types of metamorphic protoliths; textures and structures; and classification and names of metamorphic rocks.

SUGGESTED READING

Practical I: MINERALS AND ROCKS - (Course No. GEO-C-GE2BP)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60  
Credits: 2

1. Study of various physical properties of minerals. Study of the following minerals in hand specimen: olivine, garnet, kyanite, andalusite, sillimanite, orthoclase, plagioclase, sodalite, quartz and its varieties, titanite, staurolite, beryl, tourmaline, hypersthene, diopside, augite, anthophyllite, tremolite, actinolite, hornblende, muscovite, biotite, lepidolite, phlogopite, talc, chlorite, serpentine, asbestos, apatite, calcite, barite, fluorite and corundum.

2. IUGS classification of igneous rocks.

B.Sc. (Hons.) Course in Geology

II Year

Semester III and IV
Outlines of Tests, Syllabi and Courses of Reading for B.Sc. (Honours: under the Framework of Honours School System) II Year in Geology (Choice Based Credit System) Examinations 2019-20, 2020-21 and 2021-22

III Semester Examination

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**Practical: Core Course**

| I     | GEO-C5P| Igneous Petrology      | 2      | 10                | 40                       | 50          |
| II    | GEO-C6P| Sedimentary Petrology  | 2      | 10                | 40                       | 50          |
| III   | GEO-C7P| Palaeontology          | 2      | 10                | 40                       | 50          |

**Skill Enhancement Course**

| I     | GEO-SEC1| Field Geology 1*       | 2      | Field Work        | 25                       | 50          |
|       |         |                        |        | Field Report      | 25                       |             |

**Total Credits & Marks**

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*Compulsory

**Paper I: IGNEOUS PETROLOGY - (Course No. GEO-C5)**

**Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]**

**Total Lectures: 60**

**Credits: 4**

Objectives: This course aims to understand forms, textures and structures of igneous rocks. It is also aimed to study crystallisation behaviour of magmas, various processes of magmatic differentiation, and petrogenesis and tectonic settings of important igneous rocks.

**UNIT 1: Concepts of Igneous Petrology (15 hrs)**

Introduction to petrology; Generation of melts (melting of mantle and factors controlling melting of mantle); Heat flow, geothermal gradients through time and space; Composition of magma, volatiles in magma; Properties of magma: viscosity & density; Rise of magma; Convection in magma; Forms and structures of extrusive and intrusive igneous rocks; Igneous textures; Classification (mineralogical including IUGS and chemical) and nomenclature.
UNIT 2: Phase Diagrams and Magma Diversification (15 hrs)

Basic principles of thermodynamics: system, equilibrium, phase, component, entropy, chemical potential, phase rule and variance. One component system (SiO$_2$ system); Binary systems (solid solution: Albite-Anorthite and Forsterite-Fayalite systems; eutectic: Diopside-Anorthite system; peritectic: Forsterite-Silica system; solid solution and eutectic: Alkali feldspar system); Ternary systems (eutectic: Anorthite-Diopside-Forsterite system; solid solution and eutectic: Diopside-Albite-Anorthite system). Magmatic processes of magma diversification: differentiation, fractional crystallisation, liquid immiscibility, magma mixing and assimilation.

UNIT 3: Petrogenesis and Tectonic Setting-I (15 hrs)

Classification, petrography, chemistry, tectonic setting and petrogenesis of: Layered mafic intrusions; Komatiites; Ophiolites; Mid-ocean ridge basalt (MORB); Ocean island basalt (OIB); Continental flood basalt (CFB).

UNIT 4: Petrogenesis and Tectonic Setting-II (15 hrs)

Classification, petrography, chemistry, tectonic setting and petrogenesis of: Island arc magmatism; Continental arc magmatism; Granitoid rocks; Continental rift magmas: Alkaline magmatism, Carbonatites, Lamprophyres, Kimberlites; Lamproites; Anorthosites.

SUGGESTED READING


PAPER II: SEDIMENTARY PETROLOGY- (Course No. GEO-C6)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objectives: The course contents are focused on major origin of sediments, sediment geometry, and understanding of textural and structural fabrics in relation to environments of deposition. Origin and classification of siliciclastic and carbonate rocks along with processes of diagenesis would also be dealt with.

UNIT 1: Origin of Sediments (15 hrs)

Weathering processes and products: physical and chemical weathering; soil origin and profiles; Palaeosols.

UNIT 2: Sediment Granulometry (15 hrs)

Grain size scale; particle size distribution; Environmental connotation; Particle shape and fabric.
UNIT 3: Sedimentary Textures, Structures and Environment (15 hrs)

Fluid flow, sediment transport: types of fluids, laminar vs. turbulent flow; Particle entrainment, transport and deposition; Paleocurrent analysis-collection, presentation, interpretation and paleocurrents for different sedimentary environments; Sedimentary structures-primary, inorganic and syn-sedimentary structures.

UNIT 4: Varieties of Sedimentary Rocks (15 hrs)

Genesis and classification of sedimentary rocks; Siliciclastic rocks: conglomerates, sandstones, mudrocks; Carbonate rocks, controls of carbonate deposition; Components and classification of limestone, dolomite and dolomitisation; Diagenesis: concepts and processes.

SUGGESTED READINGS


Paper III: PALAEONTOLOGY- (Course No. GEO-C7)

Total Marks: [100 (Mid Semester Test M.M. 20, End Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objectives: The currently taught course is related to processes and patterns of fossilization, morphology, biostratigraphy and palaeobiogeographic significance of invertebrates, vertebrates and palaeobotanical groups along with introduction of ichnology.

UNIT 1: Fossilization and Fossil Record (15 hrs)

Fossilization process and fossil record. Modes of preservation. Applications of fossils in biostratigraphy, palaeoenvironments, palaeoecology, palaeobiography and palaeoclimatology. Species concept and taxonomy with reference to paleontology and evolution.

UNIT 2: Invertebrates (15 hrs)

Brief introduction to: Bivalvia, Gastropoda, Brachiopoda, Cephalopoda, Trilobites, with their biostratigraphic and palaeobiogeographic significance.
UNIT 3: Vertebrates (15 hrs)

Origin of vertebrates and major steps in vertebrate evolution. Mesozoic reptiles, dinosaurian evolution and extinction patterns. Evolution of horse and humans.

UNIT 4: Introduction to Palaeobotany, Gondwana Flora (15 hrs)

Introduction to palaeobotany, Morphology of Gondwana flora, with Indian examples. Introduction to ichnology.

SUGGESTED READING


Practical I: IGNEOUS PETROLOGY - (Course No. GEO-C5P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. IUGS classification of igneous rocks.
2. Texture, mineral composition, and order of crystallisation of the following rock types involving handspecimens and thin section study: Granite and its varieties; Syenite and nepheline syenite; Diorite, Gabbro and Dolerite; Anorthosite; Dunite; Peridotite; Pyroxenite; Rhyolite and its varieties, Andesite, Dacite, Trachyte; Basalt and its varieties; Lamprophyre and its varieties.

Practical II: SEDIMENTARY PETROLOGY - (Course No. GEO-C6P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Exercises on sedimentary structures.
3. Paleocurrent analysis.
4. Petrography of clastic and non-clastic rocks through hand specimens and thin sections.

Practical III: PALAEONTOLOGY - (Course No. GEO-C7P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Study of fossils showing various modes of preservation
2. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.
Skill Enhancement Course: Field Geology 1: Basic Field Training - (Course No. GEO-SEC1)

Total Marks: [50 (Field Work M.M. 25, Field Report M.M. 25)  

Credits: 2

UNIT 1: Orientation of Topographic sheet in field; marking location in toposheet; Bearing (Front and back); Concepts of map reading, distance, height and pace approximation.

UNIT 2: Identification of rock types in field; Structures and texture of rocks; Use of hand lens.

UNIT 3: Basic field measurement techniques: Bedding dip and strike, Litholog measurement.

UNIT 4: Reading contours and topography; Traverse mapping.

Note: The duration of field work would be of eight days (two credits). It is mandatory for the students to maintain a systematic field diary and also to submit a well illustrated field report based on the field work. A candidate who does not attend the field work or fails to get pass marks in it will have to do the Field Work by joining the field tour of the same class in a subsequent year as per University rules.

IV Semester Examination

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| Practical: Core Course | | | | Continuous Assessment | | |
| I     | GEO-C8P | Metamorphic Petrology | 2 | 10 | 40 | 50 |
| II    | GEO-C9P | Stratigraphic Principles & Indian Stratigraphy | 2 | 10 | 40 | 50 |
| III   | GEO-C10P | Hydrogeology | 2 | 10 | 40 | 50 |

| Skill Enhancement Course | | | | No Continuous Assessment | | |
| I     | GEO-SEC2 | Field Geology 2/3/4/5** | 2 | Field Work | 25 | 50 |
|       |          | Field Report            |     |            | 25 |      |

| Total Credits & Marks | 20 | | | 500 |

**Optional: any one from 2, 3, 4 or 5
Paper I: METAMORPHIC PETROLOGY - (Course No. GEO-C8)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objective: The aim of this course is to understand textures and structures of metamorphic rocks along with applications and details of metamorphic concepts and processes.

UNIT 1: Metamorphism: Controls and Types (15 hrs)

Definition of metamorphism; factors controlling metamorphism; limits and types of metamorphism; types of metamorphic protoliths; textures and structures of metamorphic rocks; classification and names of metamorphic rocks; Phase rule and its applications; The concept of equilibrium and its application to metamorphic rocks;

UNIT 2: Metamorphic Facies and Grade (15 hrs)

Index minerals; Chemographic projections; Metamorphic zones and isograds; Concept of metamorphic facies and grades; Metamorphic facies series; Concept of paired metamorphic belts; Metamorphism of argillaceous, arenaceous, mafic and calcareous rocks.

UNIT 3: Metamorphism and Tectonism (15 hrs)

Regional orogenic metamorphic textures: tectonites, foliation and lineations; Deformation versus metamorphic mineral growth: textures of pre-kinematic, syn-kinematic and post-kinematic crystals and their S$_i$ characteristics; Analysis of polydeformed and polymetamorphosed rocks; Textures of contact metamorphism: granoblastic polygonal, deccusate, nodular, skeletal; High strain metamorphic textures, cataclasis and mylonitisation; Replacement textures and reaction rims; Pressure-Temperature-Time (P-T-t) models for metamorphism.

UNIT 4: Metamorphic Rock Associations (15 hrs)

Khondalites, Charnockites, Blue schists, Eclogites, UHT and UHP; Migmatites and their origin; Geothermometry and Geobarometry; Experimental Petrology: Methods and techniques; Application of experimental petrology to anatexis and formation of granitic magmas; Metamorphic fluids and metasomatic processes and mechanism of metasomatism.

SUGGESTED READING

Paper II: STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY - (Course No. GEO-C9)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objective: This course provides an understanding of principles of stratigraphy and brief introduction of Indian stratigraphic successions.

UNIT 1: Principles of Stratigraphy (15 hrs)


UNIT 2: Code of Stratigraphic Nomenclature (15 hrs)


UNIT 3: Phanerozoic Stratigraphy of India (15 hrs)

Tethyan Paleozoic succession. Mesozoic stratigraphy of India: Triassic successions of Spiti; Jurassic succession of Kutch; Cretaceous successions of Cauvery basin. Palaeogene and Siwalik stratigraphy.

UNIT 4: Stratigraphic Boundaries (15 hrs)


SUGGESTED READINGS


Paper III: HYDROGEOLOGY - (Course No. GEO-C10)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objective: The main emphasis of this course is on the basic concepts of hydrogeology along with principles of occurrence, chemistry movement, development and management of groundwater resources.

UNIT 1: Introduction and Basic Concepts (15 hrs)

Scope of hydrogeology and its societal relevance; Origin, occurrence and distribution of water, Types of water; Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water;
B.Sc. (Hons.) Geology

Water balance; Rock properties affecting groundwater; Vertical distribution of subsurface water, Types of aquifer, anisotropy and heterogeneity of aquifers.

UNIT 2: Groundwater Flow and Well Hydraulics (15 hrs)

Laminar and turbulent groundwater flow; Theory of groundwater flow- Darcy's law and its validity; Elementary concepts related to equilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers; Aquifer parameters-transmissivity, storage coefficient, hydraulic conductivity, transmissivity, hydraulic resistance and likage factor; Intrinsic permeability and hydraulic conductivity; Groundwater flow rates and flow direction.

UNIT 3: Groundwater Chemistry (15 hrs)

Physical and chemical properties of water; Quality criteria for different uses-Domestic, Irrigation and Industrial; Graphical presentation of groundwater quality data; Groundwater quality in different provinces in India; Groundwater contamination; natural (geogenic) and anthropogenic contaminants; Saline water intrusion in coastal aquifers.

Unit 4: Groundwater Management (15 hrs)

Surface and subsurface water interaction, Conjunctive use of surface and groundwater; Groundwater legislation.; Groundwater level fluctuations; Basic concepts of water balance studies, issues related to groundwater resources development and Management, Artificial Recharge of Ground Water- Concept of artificial recharge – recharge methods, relative merits, Applications of Remote Sensing in Artificial Recharge of Ground water.

SUGGESTED READING


Practical I: METAMORPHIC PETROLOGY - (Course No. GEO-C8P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Detailed megascopic and microscopic fabric study of rocks of different facies of metamorphism, viz. greenschist, amphibolite and granulite facies.
2. Graphic construction of ACF, AKF and AFM diagrams.
3. Estimation of pressure and temperature from important models of geothermobarometry.
4. Analysis of deformation versus metamorphic mineral growth: textures of pre-kinematic, syn-kinematic and post-kinematic crystals.
Practical II: STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY - (Course No. GEO-C9P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Study of geological map of India, and major stratigraphic basins.
2. Study of rocks in hand specimens from known Indian Precambrian and Phanerozoic stratigraphic horizons.

Practical III: HYDROGEOLOGY - (Course No. GEO-C10P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Preparation and interpretation of water level contour maps and depth to water level maps.
2. Study, preparation and analysis of hydrographs for differing groundwater conditions.
3. Graphical representation of chemical quality data and water classification (Trilinear diagrams).
4. Simple numerical problems related to: determination of permeability in field and laboratory, groundwater flow, well hydraulics, etc.

Skill Enhancement Course: Field Geology 2: Geological Mapping - (Course No. GEO-SEC2)

Total Marks: [50 (Field Work M.M. 25, Field Report M.M. 25)]

Credits: 2

UNIT 1: Geological mapping, stratigraphic correlation.

UNIT 2: Primary (scalars and vectors) and secondary structures (linear and planar).

UNIT 3: Trend, plunge, Rake/Pitch.

UNIT 4: Stereoplots of linear and planar structures, Orientation analyses.

Note: The duration of field work would be of eight days (two credits). It is mandatory for the students to maintain a systematic field diary and also to submit a well illustrated field report based on the field work. A candidate who does not attend the field work or fails to get pass marks in it will have to do the Field Work by joining the field tour of the same class in a subsequent year as per University rules.

OR

Skill Enhancement Course: Field Geology 3: Himalayan Geology Field - (Course No. GEO-SEC2)

Total Marks: [50 (Field Work M.M. 25, Field Report M.M. 25)]

Credits: 2

Identification and characterization of major structural boundaries in Himalaya viz. MBT, MFT etc. or Field along any suitable transect of the Himalayan foreland.

or
Field transect in Siwalik.
or
Identification of the Himalayan and the pre-Himalayan elements.

Note: The duration of field work would be of eight days (two credits). It is mandatory for the students to maintain a systematic field diary and also to submit a well illustrated field report based on the field work. A candidate who does not attend the field work or fails to get pass marks in it will have to do the Field Work by joining the field tour of the same class in a subsequent year as per University rules.

OR

Skill Enhancement Course: Field Geology 4: Stratigraphy & Palaeontology-related Field
- (Course No. GEO-SEC2)

Total Marks: [50 (Field Work M.M. 25, Field Report M.M. 25)]

Credits: 2

UNIT 1: Field training along Phanerozoic basin of India.
UNIT 2: Documentation of stratigraphic details in the field.
UNIT 3: Collection of sedimentological, stratigraphic and paleontological details and their representation.
UNIT 4: Facies concept and its spatio-temporal relation (Walther’s Law) and concept of facies distribution at basinal-scale.
Fossils sampling techniques and their descriptions.

Note: The duration of field work would be of eight days (two credits). It is mandatory for the students to maintain a systematic field diary and also to submit a well illustrated field report based on the field work. A candidate who does not attend the field work or fails to get pass marks in it will have to do the Field Work by joining the field tour of the same class in a subsequent year as per University rules.

OR

Skill Enhancement Course: Field Geology 5: Precambrian Geology Field - (Course No. GEO-SEC2)

Total Marks: [50 (Field Work M.M. 25, Field Report M.M. 25)]

Credits: 2

UNIT 1: Field transect in any Precambrian terrain.
UNIT 2: Study of craton ensemble including basic intrusive suites.
UNIT 3: Precambrian sedimentary basin.
UNIT 4: Basement-Cover relation in: a. fold belts, b. sedimentary successions.

Note: The duration of field work would be of eight days (two credits). It is mandatory for the students to maintain a systematic field diary and also to submit a well illustrated field report based on the field work. A candidate who does not attend the field work or fails to get pass marks in it will have to do the Field Work by joining the field tour of the same class in a subsequent year as per University rules.
Outlines of Tests, Syllabi and Courses of Reading for B.Sc. (Honours: under the Framework of Honours School System) II Year (Generic Elective) in Geology (Choice Based Credit System) Examinations 2019-20, 2020-21 and 2021-22

III Semester Examination

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Paper I: STRUCTURAL GEOLOGY - (Course No. GEO-C-GE3B)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objective: This course introduces the fundamentals of structural geology with an objective to study in detail the structures related to processes of fracturing. The main aim of this course is to appraise the structures related to deformation and tectonics.

UNIT 1: Structure and Topography (15 hrs)

Effects of topography on structural features; Topographic and structural maps; Important representative factors of the map; Concept of dip and strike; Stratum contour, clinometer compass and Brunton compass, bearing and back bearing. Stereographic projection and its use in structural geology. Thickness and width of outcrops, outlier, inlier. Unconformities: significance, onlap, offlap, types and recognition of unconformities.

UNIT 2: Stress and Strain in Rocks; Foliation and Lineation (15 hrs)

Concept of rock deformation: stress and strain in rocks, strain ellipses of different types and their geological significance. Factors controlling behaviour of rocks; Methods of determination of top and bottom of beds.

Description (definition and types) and origin of foliation: axial plane cleavage and its significance; its relationship with bedding. Description (definition and types) and origin of lineation and relationship with the major structures.

UNIT 3: Folds (15 hrs)

Fold morphology; Geometric and genetic classification of folds; Introduction to mechanics of folding: buckling, bending, flexural slip and flow folding. Causes of folding.
UNIT 4: Joints and Faults (15 hrs)

Joints: general characteristics, joint sets, joint system, major joints and their relation with other structure; use of Rose diagram and stereographic projection; joint intensity.


SUGGESTED READING

Practical I: STRUCTURAL GEOLOGY - (Course No. GEO-C-GE3BP)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Basic idea of topographic contours; Topographic sheets of various scales.
2. Introduction to geological maps: Lithological and Structural maps;
3. Structural contouring and 3-point problems of dip and strike.
4. Drawing profile sections and interpretation of geological maps of different complexities. Completion of outcrops.
5. Exercises of stereographic and orthographic projections of mesoscopic structural data (planer, linear, folded, etc.).

IV Semester Examination

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Objective: This basic fundamental course aims to understand various conceptual aspects of Earth’s evolution and its constitution. It is also aimed to study a brief account of plate tectonic processes, about hydrosphere and atmosphere and also to understand fundamentals of stratigraphy including the geological time scale.

UNIT 1: Introduction to Fossils (15 hrs)

Definition of fossil, fossilization processes (taphonomy), taphonomic attributes and its implications, modes of fossil preservation, role of fossils in development of geological time scale and fossils sampling techniques.

UNIT 2: Species Concept (15 hrs)

Definition of species, species problem in paleontology, speciation, methods of description and naming of fossils, code of systematic nomenclature.

UNIT 3: Introduction to Various Fossil Groups (15 hrs)

Brief introduction of important fossils groups: invertebrate, vertebrate, microfossils, spore, pollens and plant fossils. Important age-diagnostic fossiliferous horizons of India.

UNIT 4: Economic and Academic Application of Fossils (15 hrs)


SUGGESTED READING


Practical I: FOSSILS AND THEIR APPLICATIONS - (Course No. GEO-C-GE4BP)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]
B.Sc. (Hons.) Course in Geology

III Year

Semester V and VI
Outlines of Tests, Syllabi and Courses of Reading for B.Sc. (Honours: under the Framework of Honours School System) III Year in Geology (Choice Based Credit System) Examinations 2019-20, 2020-21 and 2021-22

V Semester Examination

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Total Credits & Marks 24 600

Paper I: ECONOMIC GEOLOGY - (Course No. GEO-C11)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objectives: This course aims to provide a detailed study of formation of various mineral deposits along with an overview of basics of ore minerals. It also focuses on Indian distribution and genesis of various metallic and non-metallic deposits, and that of fossil fuels.

UNIT 1: Ores and Gangues (15 hrs)

UNIT 2: Mineral Deposits and Classical Concept of Ore Formation (15 hrs)

Contemporary concepts of ore genesis and ore formation: Endogenous processes (magmatic concentration, lateral secretion, skarns, greisens, and hydrothermal deposits). Exogenous processes (weathering products and placer and paleoplacer deposits, residual deposits, supergene enrichment, and exhalative deposits). Indian distribution of petroleum, coal and atomic minerals.

UNIT 3: Metallic Ores/Minerals (15 hrs)

Metallogenic provinces and epochs; Metallic minerals- occurrence and Indian distribution: ferrous (iron, manganese and chromite), non-ferrous (copper, lead, zinc, tin and aluminium) and precious (gold, silver and platinum) metals.

UNIT 4: Non-Metallic Minerals (15 hrs)

Nonmetallic minerals- occurrence and Indian distribution: minerals for chemical Industries (sulphur, pyrite, barite, fluor spar and salt), minerals for glass and ceramic industries (gypsum, talc, feldspar, glass sand and clays), minerals for refractory industries (graphite, dolomite, magnesite, Al-silicates, fire clays and ball clays), minerals for fertilizer industries (rock phosphate, sulphur and gypsum), minerals for electrical industries (mica, asbestos, mineral wool and glass wool); Industrial rocks and minerals in India (limestone, clays, sand, gravel, kaolin, bentonite, asbestos, silica, barite, gypsum, kyanite, sillimanite, andalusite, talc, etc.); Introduction to gemstones.

SUGGESTED READING

Paper II: GEOMORPHOLOGY - (Course No. GEO-C12)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Objectives: The current course emphasizes understanding of basic concepts of geomorphology, landscape evolution and applied geomorphological aspects.

UNIT 1: Fundamentals of geomorphology (15 hrs)

Fundamentals of geomorphology; Geoid, topography, hypsometry; Landscape evolution: Penck and Davis concepts; Concepts of endogenic and exogenic processes and interactions.

UNIT 2: Morphometry and Tectonics (15 hrs)

Morphometric analyses; Tectonics and drainage development; Pedology: classification and origin of soil. Plate tectonic processes in relation to geomorphology; Overview of Indian geomorphology with emphasis on the Himalayan landforms.
UNIT 3: Landform Evolution (15 hrs)
Weathering and associated landforms; Geomorphic processes and landforms associated with fluvial, glacial, eolian, coastal and karst topography.

UNIT 4: Exhumation and Applied Geomorphology (15 hrs)
Processes of exhumation: upliftment and denudation; Sea level and climate changes in relation to geomorphology; Applied geomorphology; Palaeogeomorphology

SUGGESTED READING

Paper III: GEOPHYSICS - (Course No. GEO-DSE1)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objectives: The major objective of this course is to provide fundamentals of geophysics and also to comprehend geophysical exploration methods used for mineral, subsurface fault determination, water, oil and geothermal exploration.

UNIT 1: Geology and Geophysics (15 hrs)
Interrelationship between geology and geophysics; role of geological and geophysical data in explaining geodynamical features of the earth.

UNIT 2: General and Exploration Geophysics (15 hrs)
Different types of geophysical methods - gravity, magnetic, electrical, heat flow, seismic and ground penetrating radar, and their principles and applications; concepts and usage of corrections in geophysical data.
UNIT 3: Geophysical Field Operations (15 hrs)

Different types of surveys: grid and route surveys, profiling and sounding techniques, scales of survey; presentation of geophysical data, correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, and depth of exploration; ambiguities in geophysical interpretation, planning and execution of geophysical surveys.

UNIT 4: Application of Geophysical Methods (15 hrs)

Regional geophysics; oil and gas geophysics; ore geophysics; groundwater geophysics; and engineering geophysics.

SUGGESTED READING


Paper IV: EARTH’S CLIMATE AND ENVIRONMENT - (Course No. GEO-DSE2)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objectives: Main objective is to acquire knowledge on all the components of earth’s environment and their controls on human life. The course is aimed to apply the geological knowledge of students to better understand our living environment and climate in a multidisciplinary approach and acquire insights on global climatic and environmental evolution through geological time scale.

UNIT 1: Earth’s Climate (15 hrs)

Components of the climate system, climate forcing, climate controlling factors, climate system response, response rates and interactions within the climate system. Climate change: natural vs. anthropogenic effects, Milankovitch cycles and variability in the climate.

UNIT 2: Heat Budget of Earth (15 hrs)

Incoming solar radiation, receipt and storage of heat; Heat transformation; Earth’s heat budget. Interactions amongst various sources of earth’s heat.

UNIT 3: Earth’s Environment: Atmosphere–Hydrosphere-Continental (15 hrs)

Layering of atmosphere and atmospheric circulation; acid rain and ozone, greenhouse effect and climate change; Heat transfer in ocean, global water cycle, surface vs. groundwater; Global oceanic conveyor belt and its control on earth’s climate; Oceanic circulation; Glacial-interglacial stages; Processes and thermal stratification in lakes, pit lakes; Classification and chemical vs. biological processes of estuaries; Processes and composition of river systems.

UNIT 4: Monsoon (15 hrs)

Mechanism of monsoon; Monsoonal variation through time; Factors associated with monsoonal intensity; Effects of monsoon.
SUGGESTED READING

Practical I: ECONOMIC GEOLOGY - (Course No. GEO-C11P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60
Credits: 2

1. Megascopic identification of ore forming minerals: Oxides and hydroxides-magnetite, hematite, chromite, bauxite, limonite, wad, psilomelane, pyrolusite, cassiterite; sulphides-pyrite, chalcopyrite, sphalerite, galena, bornite, chalcocite; carbonates-siderite, cerrusite, malachite, azurite, rhodochrosite; banded iron formations, specularite, rhodonite.

2. Megascopic identification of metallic and nonmetallic minerals; Industrial minerals: limestone, clays, sand, gravel, kaolin, bentonite, asbestos, silica, barite, gypsum, kyanite, sillimanite, andalusite, talc, etc.

3. Preparation of maps: Distribution of important ores and other economic minerals in India.

Practical II: GEOMORPHOLOGY - (Course No. GEO-C12P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60
Credits: 2

1. Drainage patterns
2. Morphometric analyses of drainage.
3. Geomorphic maps
4. Interpretation of geomorphic processes.

Practical III: GEOPHYSICS - (Course No. GEO-DSE1P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60
Credits: 2

1. Anomaly and background- Graphical method.
2. Problems on geothermal gradient.
3. Study and interpretation of seismic reflector geometry.
4. Problems on gravity anomaly.
Practical IV: EARTH’S CLIMATE AND ENVIRONMENT - (Course No. GEO-DSE2P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60

Credits: 2

1. Study of distribution of major climatic regimes of India on map.
2. Distribution of major wind patterns on world map.
3. Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals.
5. Exercises on data interpretation about earth’s environment-numerical and map based.

VI Semester Examination

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Theory: Core Course

Theory: Discipline Specific Elective

Practical: Core Course

Practical: Discipline Specific Elective

Total Credits & Marks

24

600
Paper I: ENGINEERING GEOLOGY - (Course No. GEO-C13)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objectives: The main aim of this course is to understand the basics of geotechnical and engineering properties of rocks, rating of rock mass and application of geology to various engineering projects.

UNIT 1: Geological Parameters (15 hrs)

Geology and its relationships to engineering; Role of engineering geologists in planning, design and construction of major man-made structural features; Site investigation and characterisation; Earthquakes: causes, factors and corrective/preventive measures.

UNIT 2: Geotechnical Properties (15 hrs)

Intact rock and rock mass properties; Rock aggregates; Rock as a construction material; Concept, mechanism and significance of Rock Quality Designation (RQD); Concept, mechanism and significance of Rock Structure Rating (RSR), Rock Mass Rating (RMR) and Tunneling Quality Index (Q).

UNIT 3: Engineering Geological Investigations (15 hrs)

Foundation treatment; Grouting, rock bolting and other support mechanisms; Geological investigations for river valley projects; Geological and geotechnical studies for dams and reservoirs.

UNIT 4: Engineering Projects (15 hrs)

Tunnels and tunneling methods and problems; Landslides: causes, factors and corrective/preventive and rehabilitation measures; Case histories related to Indian Civil Engineering Projects, such as Bhakra Nangal project and Nagarjunasagar project.

SUGGESTED READING


Paper II: REMOTE SENSING & GIS - (Course No. GEO-C14)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objectives: This course aims to understand the basic principles and applications of remote sensing and geographic information system in various branches of geosciences.
UNIT 1: Photogeology (15 hrs)
Types and acquisition of aerial photographs; Scale and resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion; Elements of air photo interpretation; Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.

UNIT 2: Remote Sensing (15 hrs)
Concepts in Remote Sensing; Sensors and scanners; Satellites and their characteristics; Data formats- Raster and Vector.

UNIT 3: Digital Image Processing (15 hrs)
Image Errors; Rectification and Restoration; FCC; Image Enhancement; Filtering; Image Rationing; Image classification and accuracy assessment; GIS integration and Case studies-Indian Examples.

UNIT 4: Geographic Information System (15 hrs)
GIS; Datum; Coordinate systems and projection systems; Spatial data models and data editing; Introduction to DEM analysis; GPS, concepts of GPS, integrating GPS data with GIS; Applications in earth system sciences.

SUGGESTED READING

Paper III: EVOLUTION OF LIFE THROUGH TIME - (Course No. GEO-DSE3)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objectives: The course contents are focused on documentation of origin and evolution of life, along with periods of diversifications and major extinctions.

UNIT 1: Life Through Ages and Geobiology (15 hrs)
Fossils and chemical remains of ancient life; Major events in Earth’s history; Exceptional preservation of sites-age and fauna; Abundance and diversity of microbes and microbial mats.

UNIT 2: Origin of life (15 hrs)
Life sustaining elemental records; Archaean-Proterozoic life; Origin of life and the earliest fossils; Ediacaran life; Oxygen revolution and radiation of life; Biomineralization; Origin of vertebrates, Tetrapods, Amphibians, Reptiles and Mammals

UNIT 3: Early Plants and Mesozoic Life (15 hrs)
Early land vascular plants; Seed plants of the pre-Permian; Non-flowering plants of the Permian and post-Permian; Flowering plants and impact of land vegetation; Life after the largest (P/T) mass extinction; Life in the Jurassic seas; Origin of mammals; Rise and fall/evolution of dinosaurs; Origin of birds and spread of flowering plants. Evolution of micro-organisms.
UNIT 4: Cenozoic Life (15 hrs)

Cretaceous-Palaeogene mass extinctions – radiation of placental mammals; Cenozoic expansion of grasslands and climatic cooling; Rise of modern plants and vegetation; Thermal maxima in Earth history; Taphonomic characterization; Proboscidean evolution.

SUGGESTED READING

Paper IV: FUEL GEOLOGY - (Course No. GEO-DSE4)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60

Credits: 4

Objectives: This course addresses fundamental knowledge of Hydrocarbon geology including the coal geology. Also it will address the applications of microfossils, stratigraphy in the exploration for petroleum.

UNIT 1: Coal (15 hrs)

Definition and origin of Coal; Basic classification of coal; Fundamentals of coal petrology - Introduction to lithotypes, microlithotypes and macerals in coal; Proximate and ultimate analysis.

UNIT 2: Coal as a Fuel (15 hrs)

Coal Bed Methane (CBM): global and Indian scenario; Underground coal gasification; Coal liquefaction.

UNIT 3: Petroleum (15 hrs)

Chemical composition and physical properties of crudes in nature; Origin of petroleum; Maturation of kerogen; Biogenic and thermal effect.

UNIT 4: Petroleum Reservoir and Traps (15 hrs)

Reservoir rocks: general attributes and petrophysical properties; Classification of reservoir rocks - clastic and chemical; Hydrocarbon traps: definition, anticlinal theory and trap theory; Classification of hydrocarbon traps - structural, stratigraphic and combination; Time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and general properties. Plate tectonics and global distribution of hydrocarbon reserves; Gas hydrates and nuclear fuel.

SUGGESTED READING
Practical I: ENGINEERING GEOLOGY - (Course No. GEO-C13P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60   Credits: 2

1. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
2. Study of maps and models of important engineering structures, such as dam sites and tunnels.
3. Merits, demerits & remedial measures based upon geological cross sections of project sites.
4. Computation of index properties of rocks;
5. Computation of RQD, RSR, RMR and ‘Q’

Practical II: REMOTE SENSING & GIS - (Course No. GEO-C14P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60   Credits: 2

1. Aerial Photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.
2. Introduction to DIP and GIS software. Digital image processing exercises including analysis of satellite data in different bands and interpretation of various objects on the basis of their spectral signatures; Creating a FCC from raw data.
3. Registration of satellite data with a toposheet of the area, Enhancing the satellite images; Generating NDVI images and other image ratio and its interpretation; Classification of images.
4. DEM analysis: generating slope map, aspect map and drainage network map and its applications.

Practical III: EVOLUTION OF LIFE THROUGH TIME - (Course No. GEO-DSE3P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60   Credits: 2

1. Study of modes of fossil preservation.
2. Study of fossils from different stratigraphic levels.
3. Exercises related to major evolutionary trends in important groups of animals and plants.

Practical IV: FUEL GEOLOGY - (Course No. GEO-DSE4P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60   Credits: 2

1. Study of hand specimens of coal
2. Reserve estimation of coal
3. Core and cuttings samples, section correlation and identification of hydrocarbon prospect.